

Understanding the Growth Process in Sub-Saharan Africa: Some Empirical Estimates

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Abstract

In this paper some recent examples from the development literature are reviewed to illustrate the types of issues examined using single equation growth regressions and the problems encountered. The results of these exercises show that, in general, that methodological approach has been pushed well beyond any useful analytical limit. Income growth cannot meaningfully be determined by a dozen or more macro level variables that are presumed to be independent of income growth.

Three findings are noteworthy. One. The impact of foreign aid on economic growth is indirect, operating through the growth of investment. Two. Over the sample period (1970 to 1998) the growth of the non-agricultural sector has been associated with a significant *reduction* in the growth of agriculture. And, three, there is evidence that exchange rates are highly responsive to both domestic and foreign inflation and that, over longer periods, they have changed in ways consistent with trends in relative purchasing power parity.

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1. Introduction

The analysis in this paper has been stimulated by what we believe are novel insights about the relationship between trade and growth reported in a companion study.¹ That study demonstrated the importance for analytical purposes of moving beyond single equation growth regressions to examine the determinants of income growth within the context of a multi-equation system.²

This paper takes the same approach. We analyze some of the factors and processes that have been associated with economic growth in sub-Saharan Africa (SSA). Specifically, we use time series data from 33 countries in SSA over the period 1970 to 1998 to derive the parameters of a simultaneous equations system in which the growth of real income is one of several jointly determined variables.

Cross-country studies of economic growth almost invariably use single equation techniques. Typically, the growth of real income (or real income per capita) is regressed on a large number of economic, institutional, social, and political variables. These variables are selected because there are theoretical or practical reasons to believe that they contribute directly or indirectly to (a) an increase the supply of productive factors; (b) raise the intensity with which the productive factors are used; and/or (c) improve their efficiency.

Such growth regressions are used to identify ‘sources of growth’ or (following Barro) the ‘determinants of growth.’ The estimated coefficients are interpreted as a measure of the relative contribution of each right hand variable to the growth of income. When comparisons are made across regions, the coefficients are seen as measuring the relative strength of the determinants of differences in regional growth rates.³ Many of the coefficients in these growth regressions are statistically significant. Notwithstanding the wide range of theory that is marshaled to justify the inclusion of each variable, interpreting the results remains problematic.⁴ As shown in this paper, the main problem is that once allowance is made for inter-dependence and feedback among the regressors and the growth of income, the coefficients derived in the single equation growth regressions do not have a straightforward or unambiguous interpretation.⁵

The problems with single equation growth regressions have been widely analyzed and are regularly noted in the texts or substantive footnotes of the studies in which they are reported.⁶ Yet, having tipped their hats to the issue, most analysts proceed to interpret their results as though the statistical problems are inconsequential.⁷ This is a fundamental mistake. Over the periods covered by the single equation growth regressions (typically three decades) an economy’s growth trajectory is a key determinant of its economic performance. That is, through its direct and indirect linkages to other macroeconomic variables, income growth itself is a ‘determinant’ or ‘source’ of growth.

Single equation growth regressions systematically suppress this aspect of the growth process. In doing so, they distort the empirical estimates of the factors that contribute to or detract from income growth. This problem can be dealt with by broadening the empirical studies to incorporate inter-dependence and feedback. With few exceptions,⁸ there has been little effort to do this.⁹

The present paper moves beyond the single equation growth regression studies of Africa's economic performance by specifying and estimating a multi-equation system. The system includes as endogenous variables the annual growth rates of real income, investment, prices (i.e. inflation), the exchange rate, real exports, and real agricultural output. Exogenous variables in the system include the growth of money, change in foreign aid, foreign inflation, and population growth. The estimation procedure is three-stage least squares (3SLS).

The paper is arranged as follows. Section 2 has a brief discussion of several recent studies that illustrate key features of explanations of Africa's economic performance based on single equation growth regressions. Section 3 outlines the simultaneous system that we use to capture some of the main interactions among income growth and other key macroeconomic variables. Section 4 presents the econometric results and discusses their implications. Section 5 has concluding comments, including suggestions on how the results we obtain might assist Africa's policy makers in their efforts to promote and sustain growth and development.

2. Studies of Growth in Sub-Saharan Africa

a. Historical Overview

Africa's poor economic performance has been widely studied. Collier and Gunning (1999) provide an excellent review of the recent literature. An important conclusion they reach is that the views among specialists about the factors that have promoted or impeded growth in Africa continue to change over time.¹⁰ Issues that once appeared to have been settled re-emerge, and suggestions that a consensus on dealing with the problems invariably prove to be premature.

A convenient way to trace the changing viewpoints is to consider the basic themes reflected in the contents and conclusions of the six major studies of SSA by the World Bank over the last two decades. The first of these, the Berg Report of 1981, (World Bank 1981) provided an "agenda for action" designed to "accelerate development in Sub-Saharan Africa." Development, however, did not accelerate. An obvious reason was the onset of the debt crisis of the early 1980s. Three years after the Berg Report, World Bank staff formulated a "joint [government-donor] program of action" designed to move SSA "toward sustained development" (World Bank 1984). When donors declined to provide the (large) volume of resources required for this program, the "joint" strategy unraveled.

Africa's economic difficulties intensified. In response, World Bank officials focused more directly on reviving economic growth. A third report, covering the period 1986 to 1990, examined the problem of "financing adjustment with growth" in SSA (World Bank 1986). The shift in emphasis from development to growth did not substantively improve the situation. Opinions differed over the reasons. Many donor officials began to argue that African governments were not serious about pursuing economic reform. African governments, with support from agencies such as the United Nations Economic Commission for Africa (ECA/AOU 1989), argued that the donor organizations failed to provide the necessary financial and technical support. A further World Bank study in 1989 continued to emphasize economic growth (World Bank 1989). This study suggested that African economies were beginning to move beyond the disruptions of the previous decade and a half. The main challenge for African countries was to

create the conditions (macroeconomic stability, improved governance, and debt rationalization) that would sustain growth.

In its next report, “Adjustment in Africa: Reform, Results and the Road Ahead” published in 1993, the World Bank shifted from analysis and prescription to description and review. It concluded that adjustment in Africa had produced mixed results (World Bank 1994). No government had taken all the measures needed for its economy to recover fully. Most countries had only been partially reformed. The message was clear. African countries could move ahead only if their governments were consistent, systematic, and vigorous in their pursuit of reform.

The most recent World Bank study, “Can Africa Claim the 21st Century?” departs from earlier approaches (World Bank 2000). The message lacks optimism and the prescriptions are guarded. Whereas previous reports had argued that with adequate resources from abroad and the necessary commitment to reform by African governments, growth would revive, this study is ambivalent. After so many false starts, so many dead ends, so much disruption, and the dissipation of such large amounts of local resources and foreign assistance, there is little confidence that African countries can, or will, grow vigorously in the foreseeable future.

Of course, Africans themselves have experienced the erosion of confidence for years. Few local residents have been willing to invest in Africa. For their part, foreigners have only invested in highly selected areas and activities. For all investors (local and foreign), Africa remains a last resort rather than the last frontier.

b. Selected Growth Studies Related to Africa

In the process of conducting these studies, the World Bank assembled a large database on many dimensions of Africa’s development experience. Over the last decade a growing number of development specialists have examined these data to better understand the statistical determinants of Africa’s growth performance. To provide a context for our later discussion, we briefly review seven of these studies indicating the types of issues considered and conclusions reached.

The first study, by Easterly and Levine (1995), seeks explanations for what the authors call Africa’s “growth tragedy.” The second study, by Radelet, Sachs and Lee (1997), analyzes the factors that have contributed to differences in growth rates between a sample of Asian and African countries. The third, by Sachs and Warner (1997), attempts to measure the “sources of slow growth” in Africa. The fourth, by Block (1998), asks whether African countries “grow differently” from those in other regions. The fifth study, by Calamitsis, Basu and Ghura (1999), identifies empirically the main factors fostering adjustment and growth in SSA. In the sixth study, Fosu (1999) explicitly notes that Africa’s poor performance is the result of internal and external factors. Confining his attention to external factors, Fosu assembles evidence showing that Africa’s exports have been determined exogenously and that exports have driven income growth. The final study, by Easterly (1999), searches for reasons for the poor performance of developing countries in general. Easterly concluded that growth in developing countries had been systematically reduced by shocks that spilled over from developed countries.

These studies overlap in obvious and intentional ways. Taken together they help us identify many of the important factors that have affected economic growth in Africa. Since all of the studies rely on standard single equation growth regressions, their principal value is to highlight potentially fruitful associations between the large number of right hand variables and economic growth.

Easterly and Levine begin their paper “Africa’s Growth Tragedy, A Retrospective 1960-89” with the observation:

Africa’s economic history since 1960 fits the classical definition of tragedy: potential unfulfilled, with disastrous consequences (p.1).

After describing the main features of the tragedy, now so familiar to African scholars, they move to explanations. Using several growth regressions, they examine a number of factors that are directly related to growth or indirectly influence growth performance through spillover effects.

They derive their basic equation from a model of long-term growth. It has a “core” consisting of a “fairly standard set of right-hand-side variables” (p.5) as well as several dummies to take account of continent-wide influences. The variables include initial income (to trace convergence effects), human capital (as measured by average educational attainment), financial depth, black market exchange rate premium, and central government surplus. Easterly and Levine also “experimented with” measures of inflation and trade but these were not statistically significant. They added other variables to the core regression in order to take account of “the effects of institutions, wars, terms of trade, infrastructure, and ethnic conflict” (p.10). The authors allowed for spillover effects by including the growth rates of neighboring countries in their regressions.

Reviewing their results, Easterly and Levine conclude:

... poor growth is strongly associated with (1) low schooling, (2) political instability, (3) under-developed financial systems, (4) distorted foreign exchange markets, as measured by the black market premium, (5) high government deficits, (6) low infrastructure, (7) ethnic fractionalization, [and] (8) spillovers from neighbors that magnify (1) – (7) (p. 19).

The study by Radelet, Sachs and Lee (1997) examines cross-country *differences* in rates of growth between Africa and Asia.¹¹ Their estimates highlight the relative importance for growth of efficient bureaucracy and institutions, good macroeconomic management, and strategies that enhance productivity. Using a growth accounting exercise for the period 1965 to 1990, the authors explain a significant portion of the difference in average annual growth rates under two headings, “policy variables” and “demography.” The policy variables are (a) government savings rate; (b) openness; and (c) institutions.

The aggregate nature of their analysis confounds the effects of specific policy variables. Nonetheless, the statistical significance of the variable “institutions” points to the complex web of decisions, policies, and actions that enhance the efficiency of public bureaucracies, improve the competence of public sector administrators, promote effective implementation of policies and programs, maintain accountability, and enhance governance. The significance of the

“government savings rate” is evidence of policies, decisions, and administrative actions that ensure governments conduct their affairs in ways that avoid (or overcome) distortions. The most common distortions that undermine growth in Africa are deficit financing, the rapid accumulation of domestic and foreign debt, ill-advised attempts to fix the exchange rate and interest rates, and interventions that hinder financial development. The variable “openness” represents policies and actions that enhance international competitiveness, promote sustained increases in total factor productivity, and encourage public and private investments that raise the level of output over time.

These results are suggestive. For example, using the estimated coefficients as a guide, there appears to be a direct link between economic growth (defined as sustained increases in real output per capita) and development (defined as generalized improvements in welfare). This is reflected in the significance of the demographic variable “life expectancy,” an outcome consistent with a growing body of evidence suggesting that there is no trade-off between rapid growth and poverty reduction.¹² Yet, we also know from African experience that the relationship linking growth and poverty reduction is complex and largely indirect.¹³ On average, African countries have had exceedingly low growth rates, accompanied by increased poverty and welfare regression. By contrast, rapid growth in Asia has been accompanied by widespread poverty reduction and improving welfare.

The paper by Sachs and Warner (1997) is entitled “Sources of Slow Growth in Africa.” Their analysis draws upon earlier studies of Africa’s growth performance, though it also produces some new insights. Cast within a standard growth accounting framework, Sachs and Warner relate the growth of income per capita in purchasing power parity terms to more than a dozen variables. The list includes: the log of real GDP per member of the economically active population in 1965; ‘openness’ times the log of the first variable; ‘openness’ to international trade (i.e., the proportion of years open during 1965 to 1990); landlocked dummy variable; log of life expectancy in 1970; square of the log of life expectancy; central government savings, 1970 to 1990; dummy for tropical climate; institutional quality index; natural resource exports/GDP in 1970; growth in economically active population minus population growth; dummy for SSA; growth of neighboring countries; ethno-linguistic fractionalization; average national savings rate 1970 to 1990; and average inflation 1970 to 1990.

The first eleven variables have statistically significant coefficients. The dummy for SSA is not statistically significant. Neither is growth in neighboring countries, ethno-linguistic fractionalization, national savings rate, or average inflation. Sachs and Warner interpret their findings as evidence that growth in Africa is not different from growth elsewhere. The main reasons why African countries have grown slowly are that they are landlocked, predominantly tropical, have weak institutions, and have maintained counterproductive policies. The latter are evident in persistent budget deficits and commercial policies that close off African economies to international competition.

In the fourth study, Block (1998) inquires “Does Sub-Saharan Africa Grow Differently?” Seeking to move beyond analyses that treat SSA “primarily as a dummy variable in a single reduced-form growth regression,” Block considers whether in Africa the “mechanisms of economic growth ...operate differently.”¹⁴ He does that using an “augmented reduced form”

growth regression. The model is augmented by specifying separate equations for some explanatory variables in the growth regression. Block's growth regression includes initial per capita income, life expectancy at birth, a dummy for landlockedness, a political risk index, the growth rate of the net barter terms of trade, the Sachs-Warner index of openness, the overall budget deficit including grants, the difference between the population growth rate and the growth rate of the economically active population, real investment, and the growth rate of the population.

Even with the extra statistical care, Block's results offer little that is new. Like Sachs and Warner, he concludes that countries in SSA do not grow differently from countries elsewhere. He does find, however, that the factors influencing growth are weaker in SSA. He also finds that their effects have been undercut through inappropriate policies and institutional barriers. Block concludes that weak institutions and poor policies in SSA have been far more costly in terms of growth than in other regions.

The fifth paper by Calimitsis, Basu and Ghura (1999) begins with the optimistic view that some African countries are "on the move."¹⁵ They caution, however, that the social and economic situation in most African countries remains "fragile." For policy makers, the challenge is to sustain the momentum, focus on growth and poverty alleviation, and "integrate [Africa] fully into the world economy."

The authors' goal is to determine the empirical impact of adjustment on economic growth (measured as the change in real per capita income). They use the results to suggest the types of changes needed to stimulate growth and reduce poverty. Their growth regression includes initial income, population growth, ratios of private and government investment to GDP, index of human capital, dummy for sustained IMF programs, rate of inflation, standard deviation of inflation, central government budget deficit (excluding grants), change in real effective exchange rate, rate of export growth, percentage change in external terms of trade, index of political freedom, dummy for war, and series of country and time specific dummies.

Expecting simultaneity bias due to endogenous regressors to be a problem, they run a number of tests. Concluding that the tests show no such bias, they turn to their results.¹⁶ These show that private investment is a more robust determinant of growth than government investment. Human capital has a positive but not significant effect on income growth. And population growth has a major negative effect. The estimated coefficients of the budget deficit and real exchange rate are negative and that of export growth is positive. An interesting finding is that inflation has the correct (negative) sign but is not statistically significant. The authors also find that sustained implementation of IMF programs leads to an increase in per capita income growth.

The sixth paper is "The International Dimension of Growth in Sub-Saharan Africa" (Fosu 1999). The author begins with the assertion that Africa's "uneven" growth performance has resulted from both internal and external factors. His analysis, however, focuses on the importance of external factors. In particular, he concentrates on questions related to "openness." Acknowledging that openness and the growth of exports are not the same, he nonetheless frames his analysis in terms of a growth accounting approach that defines income as a function of capital, labor, and exports. After some manipulation (logarithmic differentiation and several

substitutions), Fosu derives the equation he estimates. It relates the growth of real income to the growth of labor, the ratio of investment to income, the growth of exports, and a term (the ratio of exports to non-exports) designed to measure the “externality” effects of trade.

This equation is then estimated for a cross-section of African countries for the periods 1960-70 and 1970-80. The results show that exports are positively related to the growth of income and that the coefficient is statistically significant. Fosu also concludes that external shocks, the real exchange rate, foreign aid, and debt were important determinants of growth. He suggests that debt had a threshold effect. Below a particular threshold of gross domestic investment to GDP the level of debt raises the rate of growth; above the threshold, debt lowers the rate of growth. Finally, Fosu examines the endogeneity of exports and the direction of causation between growth and exports. He concludes that exports were exogenous and that causation ran from exports to income. There are now several studies that reach the opposite conclusions (Rodrik 1998; Summers 1999; Frankel and Romer 1999).¹⁷

The final paper by Easterly (1999) is entitled “The Lost Decades: Explaining Developing Countries’ Stagnation 1980-1998.” It begins with the observation that there was no change in the median per capita income in developing countries during the 1980s and 1990s. This contrasted with an increase of 2.5 percent recorded for the period 1960 to 1979. Easterly examines whether the loss of growth was the result of “(1) good policies that did not achieve desired results, (2) bad economic policies, or (3) some third factor like shocks?” Based on his evidence – cross-country regressions and comparison of turning points that relate events in the rich countries to those in the developing countries – he argues that the most likely explanation was point (3). The principal shock he finds was the “growth slowdown in the industrial world.”

This conclusion would resonate widely in African capitals. African leaders have persistently argued that their countries could not grow because of the impact of periodic shocks that originate outside Africa. Echoing the dependency thesis once so common in Latin America, African leaders still see their countries as victims of a larger ‘game’ within which they are inconsequential players and over which they have no influence.

c. Issues Raised In These Studies

These studies raise a number of issues that can be broadly grouped under two headings (a) feedback and joint dependence; and (b) data and definitions. The literature has covered many of the problems that arise in the context of single-equation growth regressions.¹⁸ We do not intend plowing this sand. Our concern here is points that are frequently glossed over.

The basic issue that arises concerning feedback and joint dependence is that over the period considered in all the above studies – the three decades from the sixties to the nineties - the trajectory along which growth occurred is an important determinant of economic performance. Thus, in Easterly and Levine’s study, a key dimension of the “growth tragedy” is the lack of growth. Similarly, in Sach and Warner’s analysis, a basic ‘source of slow growth’ is slow growth itself. All macroeconomists understand the linkages. Investors find little reason to commit their resources if they do not foresee robust future growth. Moreover, when growth has been low, few investible resources will be generated, either directly as business profits or indirectly as

individual savings. Furthermore, if slow growth has been accompanied by instability (as is so common across Africa), local investors will be encouraged to shift their resources abroad. For their part, foreign investors will tend to wait to see if conditions improve. All of these changes systematically undermine an economy's actual and potential growth.

That Easterly/Levine, Sachs/Warner and others chose not to emphasize the feedback from growth to economic performance does not diminish its importance. It simply reflects the partial and incorrect view of the factors that these and other authors have used to determine economic performance.

On a related point, Sachs/Warner and Block miss an important dimension of the growth experience in Africa when they argue that African countries do not grow any differently from countries elsewhere. Their conclusion is based on their evidence showing that the elements that stimulate or retard growth in Africa (factor accumulation and counterproductive policies, for example) are common across regions. Yet, what they miss and what is not common to other regions, has been the extended period of slow and disrupted growth in Africa. It is this aspect of Africa's experience that has been different and which has fed back to affect economic performance.

Looking at Easterly's analysis of the adverse impact of shocks in developed countries on developing countries, we soon conclude that the issue is not the existence of shocks. They always occur. The main question, which is a joint dependence problem, is the response of the countries undergoing the shock. Historical experience shows that shocks have adverse effects only to the extent that governments fail to adjust their policies appropriately (Bevan, Collier, and Gunning 1989; Asea and Reinhart 1996). Indeed, many developing countries have thrived by taking advantage of different market niches even when growth in rich countries is weak. Mauritius is an obvious example from Africa.

Yet, on this point, Easterly considers only one side of the linkage between developed and developing countries. He fails to distinguish whether the shocks undermine growth or whether governments accentuate the effects of the shocks through their policy responses. This is an area where comparisons between Africa and Asia yield markedly different development trajectories. Countries in both regions experienced major shocks. However, Asian countries tended to adjust to the imbalances created by the shocks. By contrast, African countries predominantly attempted to finance their imbalances (Lewis and McPherson 1994). That attempt led to debt problems from which most African countries have not yet recovered.

An issue that is habitually overlooked in empirical growth regressions is the impact of the various filters (in the form of data averaging) on both the data and the results. Filters are used to enable analysts to focus on longer-term trends.¹⁹ Nonetheless, there is no uniformity in filtering procedures. Data have been transformed using four, five, ten, and even twenty-five year averages. All filters suffer from "end-point" problems. All filters "leak" so that some time-series components in the data are amplified or attenuated more than the analyst intends.²⁰ The choice of filter to apply is not simply an empirical matter as some reviewers imply.²¹

The growth literature contains many references to measurement problems, missing data, outliers, and other statistical deficiencies.²² What has not been covered is the error that arises due to the shift in the ratio of formal to informal activities. These are most prevalent in economies in transition, both when they are declining and when they are recovering.²³ Key data such as GDP have a number of well-known biases. For example, the economic activities of women are under-recorded. Some activities such as sex-work, the drug trade and poaching are omitted. The value of variables such as self-consumed production is distorted. Various items of capital expenditure are frequently mis-classified as recurrent. Under stable conditions, these deficiencies represent a relatively constant degree of mis-measurement that does not seriously undercut the usefulness of GDP, for example, as a consistent point estimate of overall economic activity.

But, when an economy is collapsing, a significant portion of economic activity shifts into informal or parallel channels. This overstates the decline in measured GDP. During recovery, the reverse occurs. A further difficulty is that these shifts tend to be asymmetric. While the ratio of formal to informal activity declines rapidly during collapse, it shifts back only slowly in a recovery. This behavior is consistent with well-known theoretical work on safety-first, option value theory, and irreversibility. When conditions are unstable and uncertainty is high, asset holders develop defensive strategies (some of which involve sending their assets abroad) that they unwind slowly after recovery has fully taken hold.

Dealing with these matters is not easy since cross-country data will reflect each problem at a different stage. Some analysts have suggested that proxies be used. They argue that electricity usage and real money demand are more stable measures of the 'true' patterns of aggregate supply and demand (Schneider and Enste 2000). Proxy variables, however, introduce their own biases.

The basic practical response is to recognize that problems exist and open the empirical models to as many external effects as possible. In this way, no particular bias is likely to dominate. Moreover, the coefficients of the empirical relations being used for macro analysis should be regularly re-estimated as the data are updated and revised. Finally, recognizing the biases involved, cross-country comparisons should be interpreted with care.

Such care is not always taken in the literature. Some authors find evidence that particular variables are important, while others find no such evidence. For example, Easterly and Levine (1995) found that "ethno-linguistic fractionalization" had been a significant determinant of the "growth tragedy" in Africa. Using essentially the same data set, Sachs and Warner (1997) found no such association.

This outcome has two explanations. The first is the fragility of growth regressions noted by Levine and Renelt (1992) and Levine and Zervos (1993). Their work demonstrates that single equation growth regressions are sensitive to the time periods used, the selection of right hand variables, and the various manipulations to which the data are subject. This is not surprising given the multitude of indirect associations and feedback relationships that are submerged in the right hand side of each growth regression.

Another explanation however, is regularly overlooked. With most growth regressions containing more than a dozen explanatory variables, multi-collinearity builds up as more are added to the right hand side. In technical terms, the number of independent directions (or principal components) of the hyperspace spanned by the regressors is limited. Adding more variables simply increases the probability that one or more is an approximate linear combination of the others.

For statistical reasons, therefore, it is no surprise that Sachs and Warner's results begin to unravel once they move beyond their "core" variables. When the added variables do not represent an independent direction in the data set, the statistical significance of all existing coefficients declines.

This points to a more general problem in the discrimination of relevant variables. With so many potential 'sources' or 'determinants' of growth from which to choose (cf. Sachs and Warner, p.349), how do growth empiricists decide what variables to include and exclude? The empirical test used by Sachs and Warner (i.e., explains 90 percent of the variance) is arbitrary. Other analysts have achieved this explanatory power with a different set of variables. The issue has not been effectively addressed in the literature. Temple's (1999) survey, though excellent in many regards, only highlights what has and has not worked in a wide range of different models. Lacking from all of these growth analyses is a 'test' of growth determinants using a standard data set and time period.

As a final point, the increase in the number of empirical growth studies has led to a search for new and broader concepts. Such exercises are useful, particularly when they produce novel approaches to familiar issues. But, the efforts can also go awry.

Burnside and Dollar published research in 1997 showing that foreign aid had a positive effect on economic growth but only in the context of supportive policies. They used a single equation growth regression in which foreign aid was defined as "effective development assistance" (EDA). Defined as grants plus the grant component of concessional loans, it was seen as a "truer estimate of foreign aid" than the conventional measure of "official development assistance" (ODA). This approach raises two concerns. Burnside and Dollar did not establish for whom this measure of aid was a "truer estimate." In fact, none of the individuals and organizations in the aid chain bases their behavior on such an estimate of aid. Furthermore, we calculated correlation coefficients between EDA and ODA for the African countries in Burnside and Dollar's sample and found they were uniformly high (above 0.95 in most cases). The implication is that EDA is informationally indistinct from ODA. For both reasons, we continue using ODA in the present study.

d. Overview

The key issue that has arisen in our review of the growth regressions is that, over the period used by the various analysts (two and three decades) the feedback from income has itself been an important 'source' or 'determinant' of economic performance. Without growth to provide some dynamism, particularly the expectation among investors that growth will continue (and

preferably accelerate) there has been no incentive for anyone to invest. Thus, slow growth has fed on itself to produce the ‘tragedy.’

Three points emerge from the studies reviewed above. First, none of them breaks new theoretical ground. Each of them seeks support for the specification used by appealing to a patchwork of theoretical contributions. Second, the analyses have contributed in several important ways to the expansion of the databases available to current researchers. Third, there are evidently many more issues that researchers believe can be shoe-horned into the growth regression framework. Temple (1999) concludes his survey with a list of open questions. Collier and Gunning (1999, 1999a) raise numerous others. And, more recently, Easterly and Levine (2000) have argued that far too much attention has been given to standard determinants of economic performance and too little attention is given to the impact of increasing returns to knowledge, organization, research and development, and macroeconomic stability. What is surprising in all of these contributions is that none of these analysts question whether the single equation growth regressions are the appropriate framework for making these assessments.

That is where they and we part company. In our view, the single equation approach has been used well beyond an appropriate limit. The problem with moving to a multi-equation system is that the heretofore neat, though by no means accurate, method of apportioning relative growth contributions to particular ‘sources’ or ‘determinants’ of growth disappears. Such an apportionment becomes less straightforward, though not impossible in a multi-equation system. One faces the task of specifying a transition matrix that apportions the share of variance of the growth rate that is explained by the relationship between variables some of which are explained in other equations in the multi-equation system.

3. Model, Data and Estimation Results

a. Model

The model we specify is designed to explain the growth of income within the context of a multi-equation system. The goal is to specifically include the interdependence and feedback among the model’s variables. Our aim is to demonstrate that when the relevant interactions among variables are incorporated through a simultaneous system, the results provide insights not evident in single equation growth regressions.

The system has six equations. These explain the growth of real income, the growth of real investment, the change in the exchange rate, inflation (i.e., the change in prices), the growth of real exports, and the growth of real agricultural output. A seventh endogenous variable, non-agricultural income, emerges from an identity as the difference between total income and agricultural income.

The exogenous variables are money growth, foreign inflation, and the change in foreign aid (measured as ODA). Population enters the system indirectly as a component of the real income per capita variable.

The structural equations in the system have been derived from a combination of theory and practical concerns. Their final specification was obtained after testing different specifications and experimenting with a range of right hand variables and lag structures. Some exogenous and predetermined variables that we expected to have an impact were not statistically significant and were subsequently dropped. The structural equations are as follows.

The equation for the growth of real income includes capital accumulation as a fundamental determinant of long-term economic growth. As in numerous other growth studies, we use the growth of real investment as a proxy for capital accumulation. From neoclassical growth theory, the increase in investment is expected to have positive effect on the growth of GDP. Initially, we had also included population growth on the right hand side of this equation but it was not significant in any run and was therefore dropped.

The growth of real exports is included to capture a widely held view among African leaders that Africa's marginalization in the world economy is due (in part) from the difficulties African countries encounter in attempting to expand their exports. The complementary view, prominent among the proponents of structural adjustment is that for African countries to grow they must expand their exports.

The change in real exchange rate appears in the growth equation in order to investigate the effect of real devaluation on African economies. There is now considerable empirical work, inspired by 'Dutch disease' considerations, that relates real exchange rates to growth. The coefficient is expected to be positive, implying that a real devaluation will stimulate growth.

We also test the direct link between the growth of foreign aid and economic growth. Given the size of net aid flows to African countries, this variable has to be included in the output growth equation. We have no *a priori* expectations regarding the sign of the coefficient. Aid flows to African countries have expanded rapidly over the last three decades as growth rates have declined. Whether that negative association carries over in the context of the model is not clear.

Finally, the lagged level of real income per capita is included as a standard way to test for long-run equilibrium convergence. A statistically significant negative coefficient would support the hypothesis of conditional convergence in the region.²⁴

With these considerations in mind, we specify the following growth equation:

$$dlny = \alpha_0 + \alpha_1 dlnINV + \alpha_2 dlnEXP + \alpha_3 dlne + \alpha_4 dlnAid + \alpha_5 lnypc_{t-1} + \varepsilon_1,$$

where **dlnINV** is the growth of real investment, **dlnEXP** is the growth in real exports, **dlne** is the rate of change in the real exchange rate, **dlnAid** is the growth of foreign aid flows and **lnypc_{t-1}** is the lag of real per capita income.

To explain the growth of real investment, we have included the growth in real income (or output), as suggested in the accelerator model, and the rate of devaluation of the real exchange rate. We have also added the growth of foreign aid. For many countries a significant portion of foreign assistance has been to construct and/or repair physical infrastructure. These foreign flows

supplement local budgets or, for many countries, ease pressure on budgets. In principle, foreign assistance permits African governments to direct some of their own resources to investment and recurrent cost financing aimed at maintaining the stock of public capital and improving the efficiency of its operation.

The investment equation is:

$$\mathbf{dlnINV} = \beta_0 + \beta_1 \mathbf{dlny} + \beta_2 \mathbf{dlne} + \beta_3 \mathbf{dlnAid} + \beta_4 \mathbf{dlnINV}_{t-1} + \varepsilon_2,$$

where \mathbf{dlnINV}_{t-1} is the lag of the change in real investment. We expect the coefficients of all terms to be positive.

The equation for the change in the nominal exchange rate incorporates elements related to trade policies and the management of the overall macro economy. Its specification reflects key elements drawn from the principle of purchasing power parity. It includes domestic inflation, foreign inflation, and the lagged growth of the exchange rate. Domestic inflation serves as a proxy for an increase in the price of non-tradable goods and services. The estimated coefficient should be positive. Foreign inflation measures movements in the prices of tradable goods and services. It is expected to have a negative coefficient.

The growth of real income (or output) is divided into two components: the growth of real agricultural income and the growth of real non-agricultural income. This split provides an opportunity for us to measure whether there has been any significant difference for exchange rate movements of agricultural or non-agricultural growth. We expect their coefficients to be positive and significantly different.²⁵

Taking these points into account, the exchange rate equation is:

$$\mathbf{dlnE} = \gamma_0 + \gamma_1 \mathbf{dlnP} + \gamma_2 \mathbf{dlnPf} + \gamma_3 \mathbf{dlnAGR} + \gamma_4 \mathbf{dlnNAGR} + \gamma_5 \mathbf{dlnE}_{t-1} + \varepsilon_3,$$

where \mathbf{dlnE} is the rate of change of the nominal exchange rate, \mathbf{dlnP} is domestic inflation, \mathbf{dlnPf} is foreign inflation, \mathbf{dlnAGR} and $\mathbf{dlnNAGR}$ are, respectively, the growth rates of real agricultural and non-agricultural incomes and \mathbf{dlnE}_{t-1} is the lag of the nominal exchange rate.

To endogenize the rate of change in the real exchange rate, the model includes an inflation equation. It is based on the modern quantity theory of money and features the growth of real income and the growth of the money supply as right hand variables. In theory, an increase in the growth of the money supply raises the rate of inflation. By increasing real supply, the growth of real income reduces the rate of inflation. Lacking a uniformly reliable measure of the opportunity cost of money (or financial assets in general), we have included the rate of change of the nominal exchange rate in the equation. Doing this links the inflation equation more closely to the system as a whole. As a means of testing the view, prevalent among African policy makers, that much of continent's inflation has been imported, we have added the foreign inflation rate. Finally, the lagged rate of inflation is included to measure the degree of inertia in price adjustment.

The inflation equation is:

$$dlnP = \xi_0 + \xi_1 dlny + \xi_2 dlnE + \xi_3 dlnM + \xi_4 dlnPf + \xi_5 dlnP_{t-1} + \varepsilon_4,$$

where $dlnM$ is the growth of nominal money supply and $dlnP_{t-1}$ is lagged inflation.

We have specified the growth of real exports to depend separately on the growth of real income in agriculture and non-agriculture. We also expect exports to depend upon movements in the real exchange rate.

The export equation is:

$$dlnEXP = \psi_0 + \psi_1 dlnAGR + \psi_2 dlnNAGR + \psi_3 dlne + \psi_4 dlnEXP_{t-1} + \varepsilon_5,$$

where $dlnEXP_{t-1}$ is the lagged value of the real exports growth.

The equation for growth of real income in agriculture draws on several threads in the African development literature. Theories of dualism and ‘urban bias’ incorporate the view that the growth of the non-agricultural sector has proceeded with few linkages to and often at the expense of agricultural growth. By contrast, theories of rural-urban migration and remittances have emphasized the flows of resources and factors that connect the performance of both sectors.

Since few African countries have had dynamic agricultural or non-agricultural sectors over the last three decades, discriminating among these separate influences is not easy, particularly at the level of aggregation used here. One reason for relating agricultural growth to outcomes elsewhere in the economy is to measure the direction and strength of the inter-connections. Our predisposition is to believe that growth in the two segments of the economy is complementary. The equation also includes the effects of trade and exchange rate policies.

The equation for the growth of agricultural income is:

$$dlnAGR = \zeta_0 + \zeta_1 dlnNAGR + \zeta_2 dlnEXP + \zeta_3 dlne + \zeta_4 dlnAGR_{t-1} + \varepsilon_6,$$

where $dlnAGR_{t-1}$ is the lag of the growth in real agricultural production and other variables are as described earlier.

b. Data

We have used annual data covering the period 1970 to 1998 for 33 sub-Saharan African countries.²⁶ The main source for the data was the World Bank Africa 2000 CD-ROM database.

The real variables GDP, investment, agricultural and non-agricultural production, and exports are measured in constant domestic currency units. The money variable is the sum of narrow money (currency and demand deposits) and quasi-money. The exchange rate is defined in units of domestic currency per US dollar. Thus, an increase in the exchange rate represents a devaluation of the domestic currency. The real exchange rate is calculated as the nominal exchange rate multiplied by the ratio of price of tradables to the price of non-tradables. Consistent with other

empirical work, we have used the US producer price index (PPI) as a proxy for changes in the price of tradables. It also serves as a measure of foreign inflation. This data series was obtained from the International Financial Statistics of the IMF CD-ROM Database, March 2000. The price of non-tradable goods and services is measured by the domestic consumer price index (CPI). Foreign aid is taken to be the Official Development Assistance series in the World Bank's database. It is measured in millions of US dollars.

All variables in the model are in first differences in natural logs. The only exception is the lagged level of real GDP per capita included in the growth equation. For theoretical reasons (related to hypotheses regarding income convergence) it is included as a level.

Some series had missing values. We used a total of 569 observations in estimating the model.

4. Estimation Results

The structural equations have been estimated using Three Stages Least Squares (3SLS). The results are reported in Table 1 in the Appendix. The estimated coefficients for each equation can be read in the columns of the table. Most of the estimated coefficients have the expected signs. There are, however, some exceptions.

a. The Equations

In the income growth equation, the estimated coefficients of the growth of real investment and the growth of exports are positive as expected and statistically significant. The strength of the mutual relationship among these variables is confirmed from the investment and exports equations where real income has the expected sign and is highly statistically significant. (That real income is decomposed into the agriculture and non-agriculture component in the export equation simply strengthens this point.)

Since a single equation growth regression of investment and exports on real income would reveal highly significant positive coefficients, the above results point immediately to the problems of interpretation that we have highlighted in the introduction.

The estimated coefficient of the real exchange rate in the growth equation has an unexpected negative sign but it is not significant at conventional levels. This result diverges from the results obtained elsewhere in single equation growth regressions. That work shows that the real exchange rate is positively related to income growth (Ghura and Grennes 1993; Ghura and Hadjimichael 1996). The extent to which our results are overpowered by the exports term in the growth equation is unclear. The results may or may not be a valid reflection of the extended (and continuing) history of inappropriate exchange rate management across Africa. This issue requires further analysis.

Foreign aid has a negative but statistically insignificant direct effect on growth. This is the result that Burnside and Dollar (referred to earlier) obtained with their "new" measure of "effective development assistance." How this result should be interpreted remains open to debate. Critics of foreign assistance would argue that it confirms their view that aid has not made a useful contribution to growth. Proponents, by contrast, might argue that measuring the impact of aid on

its own is not a useful approach because aid only works in the context of good policies. The latter critique does not effectively hold in our analysis since the broader system reflects the influence of the various growth-oriented policies that each of the 33 countries in our sample has implemented over the last three decades. Our results show that, within the setting provided by a multi-equation model, foreign aid has not had a statistically significant impact on growth. Given the vested interests that surround the whole issue of aid, we recognize that this result will not be widely accepted.

The estimated coefficient on lagged real per capita income has a negative sign. However, it is not statistically significant. This result cannot be reassuring for those who believe that poor countries, especially in Africa, can catch up. Indeed, this result fully reflects the general view that African countries are marginalized in the world economy (Collier 1995; World Bank 1995; Yeats *et. al.* 1997).

The investment equation is dominated by income growth. Over the last three decades, African countries have been characterized by both low investment rates (by world standards) and low rates of income growth. Therefore, any increase in investment can be expected to have a high marginal impact. Such results at the margin, however, have not carried over to average returns on investment. There is now a large amount of evidence showing that average risk-adjusted returns on investment are low across Africa (Collier and Gunning 1999).

As expected the growth of foreign aid made a positive and significant contribution to real investment. This outcome raises an issue about the interpretation of the impact of foreign aid. As noted above, the direct impact of aid through the growth equation was statistically insignificant and of the wrong sign. Yet, the indirect effect of aid through the investment equation appears to be of some significance (the combined elasticity is around a quarter).²⁷ This again is an example of the value of unraveling the various influences on growth that in standard growth regressions are simply bundled onto the right hand side.

The coefficient on the change in real exchange rate in the investment equation is not statistically significant. This result is unexpected. Both in theory and in practice, movements in the real exchange rate should influence the allocation of resources. Many of the key investment goods in Africa are imported. As such, the exchange rate should have considerable impact on changes in investment. Yet, since a large part of the resources for investment in Africa over the last three decades has been supplied by the donor community, the exchange rate effect may be confounded by the impact of foreign aid. Further experimentation with this relationship is needed.

All variables in the exchange rate and inflation equations have coefficients with the expected signs. Real income growth in both agriculture and non-agriculture is associated with a general rise (devaluation) of the nominal exchange rate. This can be interpreted in two ways. First, in theory, there should be positive co-movement between incomes and the exchange rate. This stands out more clearly in annual data. Second, for many of the countries in the sample that have been undergoing structural adjustment, a key requirement is to liberalize their systems of exchange rate determination. While this has led to extensive exchange rate depreciation, it has also raised the growth rate of real incomes.

Consistent with purchasing power parity considerations, both domestic and foreign inflation have been important variables explaining the movements in the exchange rate. Foreign inflation has a highly significant and negative effect on exchange rate movements. This result shows that inflation in Africa has not been imported. The statistically insignificant coefficient on the lagged exchange rate suggests that exchange rate adjustments have been relatively rapid in the sample countries.

The inflation equation provides some interesting details. The growth of real income, as expected, has a negative effect on inflation. Improvements in real supply, all other things equal, moderate the pressure on prices. The positive and significant coefficient estimate on the exchange rate is also consistent with theory. The estimated coefficient of foreign inflation, though statistically significant, adds to the evidence from the exchange rate equation that African countries in general have not imported inflation. Indeed, over the period examined, international inflation (as measured by the United States' PPI) was significantly lower than in Africa. The rapid growth of the domestic money supply has been (and remains) a far more significant determinant of inflation in Africa. This, of course, has its roots in the widespread and persistent pattern of deficit financing. With double digit growth in the money supply, the highly significant effects of the growth in money supply has imparted major upward pressure on prices even though the estimated elasticity (0.17) appears to be low.

The equation for growth of real exports confirms an observation made earlier regarding differences in growth processes within our sample of countries. Real exports are highly dependent upon both agricultural and non-agricultural income. What is arresting about these estimates is the evidence that the coefficient of the non-agricultural income/output growth is both higher and statistically more robust than the coefficient on the growth of agricultural income. This result adds to the weight of evidence that agricultural growth linkages have been exceedingly weak across Africa. Given the overall pattern of agricultural neglect, this outcome is not surprising. It is, however, disturbing, for it means that in broad terms the one sector in which most African countries could have a competitive advantage has been allowed to languish.

The statistical insignificance of the real exchange rate in the export equation is unexpected. We anticipated that, within the context of the overall system, the real exchange rate would have a positive, direct impact on exports. Part of the explanation for its weak influence may lie in the exceedingly strong relationship between the real exchange rate and agricultural income in the last equation in the table.

The coefficient on the lag of export growth is positive and statistically significant. This suggests that trade patterns in Africa have shown a high degree of inertia. One explanation is that the dominant role of primary sector exports. That is, the growth of current exports is largely determined by historical patterns of export growth.

The final equation provides an intriguing view of the growth process in Africa over the period under review. The growth of agriculture has been seriously and significantly reduced by growth in the non-agricultural sector. There are now many potential explanations for this outcome. A sample would include: 'urban bias'; inappropriate macroeconomic policies which systematically place agriculture at a disadvantage; problems created by declining prices for agricultural

products on world markets; chronically low productivity of agriculture due to disease and distance; and weak rural growth linkages because of the lack of infrastructure and markets. For many countries, some element of each of these explanations applies. The result clearly shows that non-agricultural growth across Africa has come at the expense of agricultural growth.

Finally, the role of the real exchange rate in fostering growth in agriculture is positive and highly significant. This result adds weight to the arguments many development specialists make that African countries can boost agriculture by sharply devaluing their real exchange rates.

b. The Model as a Whole

After surveying the results, has anything substantive been gained by moving from single equation growth regressions to a multi-equation system? We believe that using a system has served two purposes. First, it has demonstrated that the single equation growth regression have no theoretical or empirical validity. No universal theory of growth links the various clusters of right variables that different analysts use to “explain” the growth of real income. The evident interdependencies that exist among right hand variables and the feedback from growth are inappropriately suppressed within the single equation framework. Thus, any statistical association that emerges from these equations has to be spurious.

Second, the multi-equation system provides a structural basis upon which the movement forward of a particular economy can be projected. Required for such projections are trends in the exogenous variables. No such exercise is possible with single equation growth regression since many of the right hand variables are themselves endogenous and jointly dependent upon the growth of real income. While this property may make little difference in the exercises that confine themselves to the decomposition of past growth performance, it is difficult to imagine how a methodology that cannot reflect the dynamics of income growth in a meaningful way can also provide valid explanations of ‘sources’ of growth.

Evidently, the results presented in this paper will not ‘settle’ any (or many) of the issues related to the usefulness of the single equation growth regressions. Far too much intellectual capital has been invested in crunching the numbers and interpreting the results. Nonetheless, for those who remain skeptical of the notion that highly complex growth processes can be more closely determined by adding additional regressors to a single equation growth regression, the results reported here offer some comfort. We have shown that inter-dependence and feed-back is important. The growth of income is also a ‘source’ of Africa’s slow growth. It is also a ‘determinant’ of Africa’s growth tragedy. To overlook this point, we argue, misses some substantial part of the story of Africa’s growth performance (or rather lack of performance) over the last three decades.

5. Concluding Comments

With few exceptions, empirical exercises seeking to understand the processes that support (or drive) economic growth have been based on single equation growth regressions. One of the first consequences of explicitly modeling the interactions across equations is that the rate of income growth is no longer directly determined by a large number of variables. This should be no

surprise. Single equation growth regressions are a brute force approach that, of necessity, submerges all but the coarsest direct associations among the regressand and regressors.

In this paper we have reviewed some recent examples from the development literature to illustrate the types of issues examined using single equation growth regressions and the problems encountered. The results of these exercises show that, in general, that methodological approach has been pushed well beyond any useful analytical limit. Income growth cannot meaningfully be determined by a dozen or more macro level variables that are presumed to be independent of income growth.

To overcome these problems and to illustrate some of the interactions and feedback effects that are confounded in single equation growth regressions, we have specified and estimated a small multi-equation system. Its purpose is to demonstrate that a number of the key relationships that form the 'core' of growth accounting exercises break down within the context of a multi-equation system and that the growth dynamics change substantially once feedback from income growth is included in the analysis.

Our model has six endogenous variables – the growth of real income, the growth of investment, the rate of change of the exchange rate, the rate of inflation, the growth of exports, and the growth of income in agriculture. The growth of real income is closely related to the growth of investment and growth of exports. These variables in turn depend on the exchange rate and growth of agricultural and non-agricultural income.

Three findings are noteworthy. One. The impact of foreign aid on economic growth is indirect, operating through the growth of investment. Two. Over the sample period (1970 to 1998) the growth of the non-agricultural sector has been associated with a significant *reduction* in the growth of agriculture. And, three, there is evidence that exchange rates are highly responsive to both domestic and foreign inflation and that, over longer periods, they have changed in ways consistent with trends in relative purchasing power parity.

This analysis can be extended in a number of obvious ways. The model can be expanded to include other factors identified as important determinants of growth such as openness, ethno-linguistic variations, fiscal deficit/surplus, foreign debt, degree of adherence to structural adjustment programs, detailed measures of human capital, and so on. Where appropriate, equations could be added to the system to incorporate additional endogenous influences. A further addition would be to test whether many of the key variables interact with a broader set of explanatory variables. Finally, for those who retain an interest in determining how much each source of growth contributed to the overall rate of growth, the estimated structure could be solved to produce a reduced form growth equation that would permit the familiar growth accounting exercise to proceed. The difference in this case is that the relative contributions of the proximate 'sources' or 'determinants' of growth would be derived in the knowledge that the model explicitly takes account of the direct, indirect, and feedback effects that connect the key variables in any macroeconomic system.

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¹ McPherson and Rakovski, Chapter 5 “Trade and Growth in Sub-Saharan Africa: Empirical Evidence” in (ed.) M.F. McPherson *Promoting and Sustaining Trade and Exchange Rate Reform in Africa* draft monograph, Belfer Center for Science and International Affairs, John F. Kennedy School of Government, Harvard University, September, 2000.

² None of these equations is a reduced form. The underlying structural system of equations was not specified. To remind, a reduced form equation expresses each endogenous variable as a function of the exogenous variables in the system. Moreover, since all of the growth regressions contain variables that would be endogenous in any appropriately specified structural system they cannot be reduced forms in any economically meaningful sense. This explains why so much attention is devoted by growth empiricists to adjusting for simultaneous equations bias (Block 1998, Temple 1999, Barro 1999).

³ An example is the study by Radelet, Sachs and Lee (1997). As noted below, it compares the growth performance of countries in Africa and Asia.

⁴ As already noted, none of the authors begins with a structural form and then derives a reduced form growth equation. If the structural form were just-identified the coefficients of the underlying structural form could be retrieved uniquely from the estimated reduced form coefficients.

⁵ Levine and Renelt (1992) explain why the regression coefficients in the single equation growth regressions cannot be interpreted as elasticities or marginal propensities. See note 8 below.

⁶ A selected list includes Sachs and Warner (1995), Easterly and Levine (1995), Ghura and Hadjimichael (1996), Radelet, Sachs and Lee (1997), Block (1998), Calimitsis, Basu, and Ghura (1999), Easterly (1999). Barro (1997) discusses at length the types of statistical problems created by the single equation approach. He uses it nonetheless.

⁷ Easterly and Levine (1995, p.4) state:

Cross-country regressions do not establish the direction of causality between growth and policy and political indicators that we study. We do not estimate structural models and the coefficients should not be interpreted as elasticities. Although we sometimes use the coefficient estimates to exemplify the strength of association between growth and policy indicators, these examples should be interpreted as suggestive illustrations, not as exploitable elasticities.

Nevertheless, the authors then use their results to construct “neighbor multipliers.” After assuming that “causality runs from policies to growth” (p.17) they conclude that regional contagion effects have been significant in Africa (pp.17-18).

⁸ The main reference is Ndulu and N’dungu (1997) who estimate a multi-equation model based on data for selected number of African countries. None of their equations, however, includes contemporaneous values of the other endogenous variables. As such, they do not include the feedback from growth that we do in our model.

⁹ Frankel and Romer (1999) specify a gravity model of trade to deal with inter-dependence of trade on income. As noted in the text, Block (1998) “augments” his model by independently explaining two variables that depend on the growth of income. These adjustments, however, are ad hoc.

¹⁰ Their own work is an obvious example (*cf.* Collier and Gunning 1999a, b).

¹¹ Their sample has 10 countries from South and East Asia and 17 in Africa.

¹² Bruno, Ravallion, and Squire 1995; Roemer and Gugerty 1997; Gallup, Radelet and Warner 1999.

¹³ Gugerty and Timmer 1999; Goldman 1999; Sen 1999; Mellor 2000

¹⁴ Block is mistaken when he refers to the problem of countries being dummies in “single equation reduced-form regressions” since, as noted earlier, none of the growth regressions used by growth empiricists is a reduced form.

¹⁵ For a period, senior officials of both the IMF and World Bank, regularly used this phrase (*cf.* Camdessus 1996; Madavo and Sarbib 1997). McPherson and Goldsmith (1998) examined whether Africa was in fact ‘on the move.’ They found that the majority of African countries had not generated the necessary conditions for Africa to remain ‘on the move.’

¹⁶ It should be noted that when Calimitsis *et al.* correct for simultaneity effects (see their note 13), the main explanatory variables become statistically insignificant.

¹⁷ As referred to above, the interconnections between trade and growth were explored in detail in McPherson and Rakovski (2000).

¹⁸ Levine and Renelt 1992; Levine and Zervos 1993; Barro 1999; Temple 1999. As this chapter moved beyond its final draft, the article by Kenny and Williams (2001) appeared asking why we know so little about economic growth despite the huge amount of research that has been devoted to the topic. Much of what they argue is consistent with the approach we have taken.

¹⁹ The most common filter is a five year average. These are typically computed on the decade and half decade (Radelet, Sachs and Lee 1997). Easterly and Levine (1995) and Barro (1997) use decade averages. Block (1998) uses five-year averages. Sachs and Warner (1997) use a 25-year average. There is no clear standard.

²⁰ Any basic textbook on time-series will show that ideal filters that “select” some frequencies in small data series and wipe out others do not exist (Hamilton 1994, pp.170-172). There is always some “leakage” across the “window.” Analysts frequently run a battery of statistical tests (t-statistics, unit root tests, etc.) on their data. No one that we can find has reported the shape of the frequency response function of the filters they apply to their data. This information is also relevant in assessing the value of the empirical work reported.

²¹ Temple (1999, p. 132) notes:

Whether one is best using annual data, or five- or ten-year averages to avoid business cycle effects, is a question that remains largely unsettled.

In addition to being ‘unsettled,’ the potential problems from leaving it unsettled continue to undermine the validity of the analysis.

²² The classic work in this area is Morgenstern (1950). Levine and Zervos (1993), Yeats (1994), and Temple (1999, section 4) are more recent contributions.

²³ We are grateful for conversations on these points with Clifford Zinnes, Harvard University, who has worked extensively on the shadow economy. A review of the key issues is contained in Schneider and Enste (2000).

²⁴ The convergence hypothesis is based on the idea that poorer countries typically have smaller stocks of physical and human capital. Under these circumstances, the marginal product of capital is higher than in richer countries, which, by definition, have larger capital stocks. Thus, for given levels of investment, the rate of growth in the poorer countries will be higher (Temple 1999:122-123; Barro 1999).

²⁵ One factor that has been widely evident across Africa has been the structural shift in the propensity to import as the share of urban population rises. This has led to a marked increase in the demand for foreign exchange. Thus, if non-agricultural incomes should grow significantly more rapidly than agricultural incomes, the coefficient estimates should differ.

²⁶ The countries in the sample were: Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Republic of Congo, Côte d'Ivoire, Ethiopia, Gabon, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, Swaziland, Tanzania, Togo, Uganda, Zambia and Zimbabwe.

²⁷ Hansen and Tarp (1999) have been highly critical of studies that find foreign aid does not have a positive and significant impact on economic growth. Their results show that foreign aid indirectly affects economic growth through a number of channels, one of which, as our results show, is investment.

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